Modeling of Microstructure Formation in Additively Manufactured IN718 with Emphasis on Porosity Prediction

Completed Technology Project (2017 - 2020)

Project Introduction

Additive manufacturing of metal parts is experiencing strong growth as powder bed machines in particular become more widely available. Although parts are being successfully made there are few tools available that allow the user to predict what the microstructure and properties of the parts will be. This project will focus on a commonly used nickel-based superalloy and develop some of the models that are needed. Porosity is a particularly important component of microstructure because fatigue typically starts from the largest flaw in the loaded volume. We will predict the pore structure that can arise from lack of fusion in additive parts based on the process conditions and scan geometry. We will further predict the pore structure that arises from the pore structure of the powder particles themselves and the way in which such pores can be trapped in the melt pool, thus persisting into the part. In order to address strength, we will develop a strength model based on the known thermodynamic data for the IN718 alloy that predicts the occurrence of precipitation reactions and the thermal histories as a function of location in a part. Experimental data for strength in additive parts will be used to refine and validate the model. Accordingly the overall objective of the project is to implement microstructure prediction models that can be used by the additive manufacturing community.

Anticipated Benefits

Development of a validated model for 3D printing of IN718 parts with known porosity and strength will increase confidence in manufacturability via additive processes that use metal powders thereby enabling use in space science & exploration. Major impact on metals additive because of the obvious need for specialized, low production volume parts. Public dissemination of the models will allow for application to essentially all additive powder bed methods and materials.

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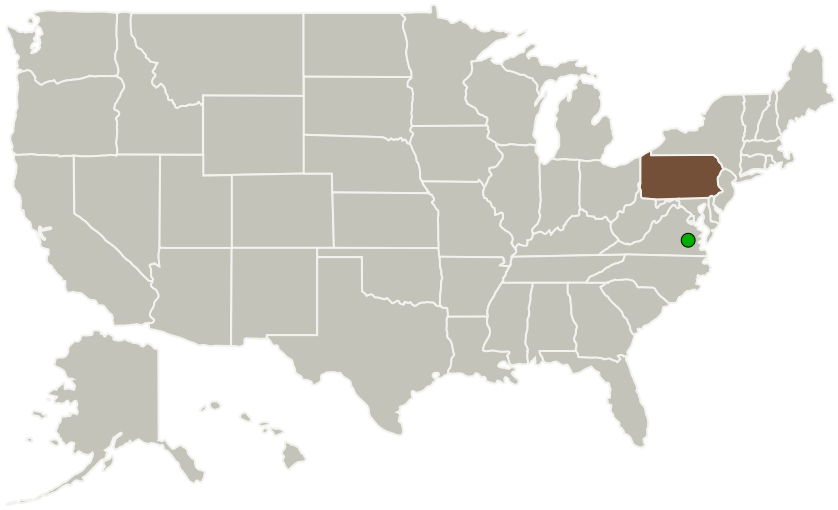
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Carnegie Mellon University	Lead Organization	Academia	Pittsburgh, Pennsylvania
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations
Pennsylvania

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Carnegie Mellon University

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

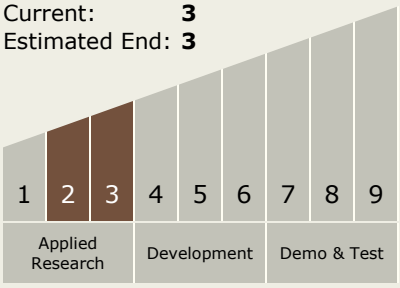
Hung D Nguyen

Principal Investigator:

Anthony D Rollett

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.2 Computational Materials

Target Destination

Outside the Solar System